DESCRIPTION

INITIATOR

TECHNICAL FIELD

The present invention relates to an initiator to be incorporated in, for example, an inflator of an airbag apparatus to be mounted in a vehicle.

BACKGROUND ART

A conventional initiator of this kind includes a pair of electrode pins held together via an insulating member; a bridge wire connected to the electrode pins and generating heat upon energization; an ignitable material (an initiating explosive) which is ignited through exposure to heat generated by the bridge wire; and a casing (capsule) for accommodating the bridge wire and the ignitable material in a sealed condition, as disclosed in, for example, Japanese Patent Application Laid-Open (*kokai*) No. 11-301402.

In the above-mentioned conventional initiator, the direction in which the electrode pins extend (hereinafter called the "extending direction") and the flame propagation direction of the ignitable material (initiating explosive) are substantially the same (substantially aligned with each other). As a result, the initiator provides poor diversity in its manner of use and may, in some cases, involve low propagation efficiency of flame energy to a gas-generating material contained in an inflator or poor workability in terms of connection of a connector to the electrode pins.

DISCLOSURE OF THE INVENTION

To solve the above-mentioned problems, the present invention provides an initiator incorporated in an inflator and adapted to trigger the inflator through propagation of flame from an initiating explosive to a gas generator of the inflator, wherein flame is propagated from the initiating explosive to the gas generator along a plurality of directions.

Since flame is propagated from the initiating explosive of the initiator to the gas generator (gas-generating material) of the inflator along a plurality of directions, flame energy can be efficiently propagated to the gas generator (gas-generating material), thereby enhancing a trigger action (ignitability) of the gas generator (gas-generating material) in the inflator.

The present invention further provides an initiator incorporated in an inflator and adapted to trigger the inflator through propagation of flame from an initiating explosive to a gas generator of the inflator, wherein the initiator comprises a closed-bottomed tubular capsule for accommodating the initiating explosive, and a tubular portion of the capsule comprises rupture-accelerating means for accelerating rupture upon ignition of the initiating explosive.

The rupture-accelerating means accelerates rupture of the tubular portion of the capsule upon ignition of the initiating explosive contained in the capsule. Therefore, in the case where the gas generator (gas-generating material) is disposed outside the tubular portion of the capsule, flame energy can be efficiently propagated from the initiating explosive to the gas generator (gas-generating material), thereby enhancing a trigger action (ignitability) of the gas generator (gas-generating material) in the inflator.

Flame may be propagated from the initiating explosive to the gas

generator along a plurality of directions. This feature relating to the direction of flame propagation enhances the efficiency of propagation of flame energy from the initiating explosive to the gas generator (gas-generating material) of the inflator, thereby further enhancing a trigger action (ignitability) of the gas generator (gas-generating material) in the inflator.

The present invention further provides an initiator incorporated in an inflator and adapted to trigger the inflator through propagation of flame from an initiating explosive to a gas generator of the inflator, wherein the initiator comprises an electrode pin to which electricity is supplied for igniting the initiating explosive, and the extending direction of a portion of the electrode pin to be connected to a connector and the direction of flame propagation from the initiating explosive to the gas generator form an angle such that the directions are not aligned with each other.

This feature relating to the angle between the portion of the electrode pin and the direction of flame propagation enhances the degree of freedom in terms of connection of the connector to the electrode pin, thereby enhancing workability in terms connection of the connector to the electrode pin.

In this case, flame may be propagated from the initiating explosive to the gas generator along a plurality of directions. Further, the initiator may further comprise a closed-bottomed tubular capsule for accommodating the initiating explosive; and a tubular portion of the capsule may comprise rupture-accelerating means for accelerating rupture upon ignition of the initiating explosive.

When the present is practiced, the plurality of directions of flame

propagation may include opposite directions with respect to the axis of the capsule, which is parallel with the extending direction of a tubular portion of the capsule. Upon ignition of the initiating explosive contained in the capsule, the rupture-accelerating means accelerates rupture of the tubular portion of the capsule that is effected along directions including opposite directions with respect to the axis of the capsule. Therefore, in the case where the gas generator (gas-generating material) is disposed outside the tubular portion of the capsule and along directions including opposite directions with respect to the axis of the capsule, flame energy can be efficiently propagated from the initiating explosive to the gas generator (gas-generating material), thereby enhancing a trigger action (ignitability) of the gas generator (gas-generating material) in the inflator.

Further, the capsule may comprise a corner connection portion connecting the tubular portion and a bottom portion of the capsule, and the plurality of directions of flame propagation may include directions substantially perpendicular to the surface of the corner connection portion. In this case, the surface of the corner connection portion may comprise rupture-accelerating means for accelerating rupture upon ignition of the initiating explosive. Upon ignition of the initiating explosive contained in the capsule, the rupture-accelerating means accelerates rupture of the tubular portion of the capsule that is effected along directions including directions substantially perpendicular to the surface of the corner connection portion. Therefore, in the case where the gas generator (gas-generating material) is disposed outside the capsule and along directions including directions substantially perpendicular to the surface of the corner connection portion, flame energy can be efficiently propagated from the initiating

explosive to the gas generator (gas-generating material), thereby enhancing a trigger action (ignitability) of the gas generator (gas-generating material) in the inflator.

When the present invention is practiced, the capsule may comprise guide means for guiding detonation force induced from ignition of the initiating explosive toward the rupture-accelerating means. Since the guide means guides detonation force toward the rupture-accelerating means, the rupture-accelerating means is enhanced in terms of acceleration of rupture.

Further, the rupture-accelerating means may be strength-weakening means implemented such that strength of the corner connection portion of the capsule is weakened as compared with that of the tubular portion and bottom portion of the capsule. The strength-weakening means accelerates rupture at the corner connection portion. In this case, the strength-weakening means may be a configuration such that the wall thickness of the corner connection portion of the capsule is reduced as compared with that of the tubular portion and bottom portion of the capsule, or the strength-weakening means may be a fragile part provided at the corner connection portion of the capsule. These strength-weakening means can be of simple configuration. In this case, the fragile part may be a groove. The groove can be formed simply and inexpensively.

When the present invention is practiced, the rupture-accelerating means may be strength-weakening means configured such that strength of the tubular portion of the capsule is weakened as compared with that of the bottom portion of the capsule. Upon ignition of the initiating explosive contained in the capsule, rupture of the tubular portion of the capsule is accelerated by means of the configuration in which strength of the tubular

portion of the capsule is weakened as compared with that of the bottom portion of the capsule. Therefore, in the case where the gas generator (gas-generating material) is disposed outside the tubular portion of the capsule, flame energy can be efficiently propagated from the initiating explosive to the gas generator (gas-generating material), thereby enhancing a trigger action (ignitability) of the gas generator (gas-generating material) in the inflator.

Further, the strength-weakening means may be a configuration such that the wall thickness of the tubular portion of the capsule is reduced as compared with that of the bottom portion of the capsule, or the strength-weakening means may be a fragile part provided at the tubular portion of the capsule. These strength-weakening means can be of simple configuration. In this case, the fragile part may be a groove. The groove can be formed simply and inexpensively.

The strength-weakening means may be a configuration such that the bottom portion of the capsule convexly protrudes into the interior of the capsule so as to relatively weaken strength of the tubular portion. Since impartment of a convex shape to the bottom portion of the capsule enhances rigidity of the bottom portion, rupture of the tubular portion of the capsule precedes rupture of the bottom portion. Therefore, in the case where the gas generator (gas-generating material) is disposed outside the tubular portion of the capsule, flame energy can be efficiently propagated from the initiating explosive to the gas generator (gas-generating material), thereby enhancing a trigger action (ignitability) of the gas generator (gas-generating material) in the inflator.

In this case, a fragile part may be provided at the tubular portion of

the capsule and is biased toward the bottom portion of the capsule from a position corresponding to the tip of a convex shape of the bottom portion. The fragile part of the tubular portion accelerates rupture of the tubular portion, thereby enhancing the efficiency of propagation of flame energy from the initiating explosive to the gas generator (gas-generating material). In this case, the fragile part may be a groove. The groove can be formed simply and inexpensively.

When the present invention is practiced, the rupture-accelerating means may be detonation-force-enhancing means implemented such that detonation force to be imposed on the tubular portion of the capsule is greater than that to be imposed on the bottom portion of the capsule. The detonation-force-enhancing means ensures rupture of the tubular portion of the capsule upon ignition of the initiating explosive contained in the capsule. Therefore, in the case where the gas generator (gas-generating material) is disposed outside the tubular portion of the capsule, flame energy can be reliably and efficiently propagated from the initiating explosive to the gas generator (gas-generating material), thereby enhancing a trigger action (ignitability) of the gas generator (gas-generating material) in the inflator.

In this case, the detonation-force-enhancing means may be implemented such that the amount of an initiating explosive for rupturing the tubular portion of the capsule is greater than that of an initiating explosive for rupturing the bottom portion of the capsule or such that an initiating explosive for rupturing the tubular portion of the capsule is greater in detonation force than an initiating explosive for rupturing the bottom portion of the capsule. This detonation-force-enhancing means can increase, in a simple manner, detonation force to be imposed on the tubular portion of the

capsule as compared with that to be imposed on the bottom portion of the capsule.

When the present invention is practiced, the angle between the extending direction of a portion of the electrode pin to be connected to a connector and the direction of flame propagation from the initiating explosive may be substantially 90 degrees. This feature relating to angle allows the connector to be easily connected to the electrode pin along the direction perpendicular to the direction of flame propagation, thereby facilitating the connection work. In this case, the angle may be formed by means of bending the electrode pin. This bending work can be carried out simply and inexpensively.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic side view with a partial cross section, showing an embodiment of an initiator according to the present invention;

FIG. 2 is an enlarged sectional view showing the initiator of FIG. 1;

FIG. 3 is a sectional view showing a first modified embodiment of the initiator of FIG. 2;

FIG. 4 is a sectional view showing a second modified embodiment of the initiator of FIG. 2;

FIG. 5 is a sectional view showing a third modified embodiment of the initiator of FIG. 2;

FIG. 6 is a sectional view showing a fourth modified embodiment of the initiator of FIG. 2;

FIG. 7 is a sectional view showing a fifth modified embodiment of the initiator of FIG. 2; and

FIG. 8 is a schematic side view with a partial cross section, showing another embodiment of an initiator according to the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

An embodiment of the present invention will now be described with the drawings. FIG. 1 shows an embodiment in which an initiator 20 according to an embodiment of the present invention is incorporated in an inflator for use in an air bag apparatus for protecting heads of persons sitting in front and rear seats of a vehicle. The inflator 10 includes a mounting portion 11a for mounting the initiator 20 and a casing 11. The mounting portion 11a is located at a longitudinally central portion of the inflator 10. The casing 11 includes a large chamber 11b and a small chamber 11c, which are located on the front and rear sides, respectively, of the mounting portion 11a and each contain a gas-generating material 12 and a combustion accelerator 13.

The casing 11 is disposed along the front-rear direction of a vehicle. The large-volume chamber 11b has gas outlet holes 11b1 through which gas is discharged into a front-seat-side inflation portion 31 of an air bag 30. The small-volume chamber 11c has gas outlet holes 11c1 through which gas is discharged into a rear-seat-side inflation portion 32 of the air bag 30. The gas-generating materials 12 are ignited and combust upon exposure to flame energy propagated from the initiator 20 upon ignition of the initiator 20 and are disposed in opposition to each other with respect to the initiator 20. The combustion accelerators 13 are highly ignitable explosive (similar to that used as an initiating explosive 25 of the initiator 20, which will be described later), accelerate combustion of the corresponding gas-generating

CLAIMS

1. An initiator incorporated in an inflator and adapted to trigger the inflator through propagation of flame from an initiating explosive to a gas generator of the inflator, wherein flame is propagated from the initiating explosive to the gas generator along a plurality of directions.

2. An initiator incorporated in an inflator and adapted to trigger the inflator through propagation of flame from an initiating explosive to a gas generator of the inflator, wherein the initiator comprises a closed-bottomed tubular capsule for accommodating the initiating explosive, and a tubular portion of the capsule comprises rupture-accelerating means for accelerating rupture upon ignition of the initiating explosive.

3. An initiator incorporated in an inflator and adapted to trigger the inflator through propagation of flame from an initiating explosive to a gas generator of the inflator, wherein the initiator comprises an electrode pin to which electricity is supplied for igniting the initiating explosive, and an extending direction of a portion of the electrode pin to be connected to a connector and a direction of flame propagation from the initiating explosive to the gas generator forming an angle such that the directions are not aligned with each other.

4. An initiator according to claim 2, wherein flame is propagated from the initiating explosive to the gas generator along a plurality of directions.

5. An initiator according to claim 3, wherein flame is propagated from

the initiating explosive to the gas generator along a plurality of directions.

6. An initiator according to claim 3, further comprising a closed-bottomed tubular capsule for accommodating the initiating explosive, a tubular portion of the capsule comprising rupture-accelerating means for accelerating rupture upon ignition of the initiating explosive.

7. An initiator according to claim 6, wherein flame is propagated from the initiating explosive to the gas generator along a plurality of directions.

8. An initiator according to claim 4 or 7, wherein the plurality of directions of flame propagation include opposite directions with respect to an axis of the capsule, which is parallel with an extending direction of a tubular portion of the capsule.

9. An initiator according to claim 4 or 7, wherein the capsule comprises a corner connection portion connecting the tubular portion and a bottom portion of the capsule, and the plurality of directions of flame propagation include directions substantially perpendicular to a surface of the corner connection portion.

10. An initiator according to claim 9, wherein the surface of the corner connection portion comprises rupture-accelerating means for accelerating rupture upon ignition of the initiating explosive.

11. An initiator according to any one of claims 2, 4, 6 and 7, wherein

the capsule comprises guide means for guiding detonation force induced from ignition of the initiating explosive toward the rupture-accelerating means.

12. An initiator according to claim 10, wherein the rupture-accelerating means is strength-weakening means configured such that strength of the corner connection portion of the capsule is weakened as compared with that of the tubular portion and bottom portion of the capsule.

13. An initiator according to claim 12, wherein the strength-weakening means is configured such that a wall thickness of the corner connection portion of the capsule is reduced as compared with that of the tubular portion and bottom portion of the capsule.

14. An initiator according to claim 12, wherein the strength-weakening means is a fragile part provided at the corner connection portion of the capsule.

15. An initiator according to claim 14, wherein the fragile part is a groove.

16. An initiator according to any one of claims 2, 4, 6 and 7, wherein the rupture-accelerating means is strength-weakening means implemented such that strength of the tubular portion of the capsule is weakened as compared with that of the bottom portion of the capsule.

17. An initiator according to claim 16, wherein the strength-weakening means is configured such that a wall thickness of the tubular portion of the capsule is reduced as compared with that of the bottom portion of the capsule.

18. An initiator according to claim 16, wherein the strength-weakening means is a fragile part provided at the tubular portion of the capsule.

19. An initiator according to claim 18, wherein the fragile part is a groove.

20. An initiator according to claim 16, wherein the strength-weakening means is a configuration such that the bottom portion of the capsule convexly protrudes into an interior of the capsule so as to relatively weaken strength of the tubular portion.

21. An initiator according to claim 20, wherein a fragile part is provided at the tubular portion of the capsule and is biased toward the bottom portion of the capsule from a position corresponding to a tip of a convex shape of the bottom portion.

22. An initiator according to claim 21, wherein the fragile part is a groove.

23. An initiator according to any one of claims 2, 4, 6 and 7, wherein

the rupture-accelerating means is detonation-force-enhancing means implemented such that detonation force to be imposed on the tubular portion of the capsule is greater than that to be imposed on the bottom portion of the capsule.

24. An initiator according to claim 23, wherein the detonation-force-enhancing means is implemented such that the amount of an initiating explosive for rupturing the tubular portion of the capsule is greater than that of an initiating explosive for rupturing the bottom portion of the capsule.

25. An initiator according to claim 23, wherein the detonation-force-enhancing means is implemented such that an initiating explosive for rupturing the tubular portion of the capsule is greater in detonation force than an initiating explosive for rupturing the bottom portion of the capsule.

26. An initiator according to any one of claims 3, 5, 6 and 7, wherein the angle is substantially 90 degrees.

27. An initiator according to claim 26, wherein the angle is formed by means of bending the electrode pin.